Establishing and Managing

Young APPLE ORCHARDS

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APPLE TREES have passed their greatest usefulness as commercial producers in most sections of the United States by the time they are 40 years old. As approximately 40 million bearing apple trees are required to produce a fruit crop of desirable size in the United States, about 12 million nonbearing or only slightly bearing trees under 10 years of age should be growing in this country to maintain the bearing acreage. A continuous development of new apple orchards is therefore desirable.

This bulletin deals primarily with the selection of sites for the apple orchard, the planning and planting of the orchard, and soil management and pruning practices for trees up to bearing age. The basic principles discussed are applicable to conditions generally throughout the main apple-producing sections of the United States.

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ESTABLISHING AND MANAGING YOUNG APPLE ORCHARDS

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IMPORTANCE OF YOUNG ORCHARDS

ACCORDING TO THE AGRICULTURAL CENSUS THERE were approximately 50 million apple trees on farms in the United States in 1950 of which about 11 million were of nonbearing age. About half of these were in orchards of 500 or more trees or of sufficient size to represent commercial production. From these trees, crops of 100 to 110 million bushels commercial production have been harvested most years from 1950 to 1956. In addition, considerable quantities of fruit from noncommercial orchards was consumed locally.

The average life of a commercial orchard for the United States as a whole appears to be not over 40 years. In northern sections, such as New England, New York, and Michigan, where trees develop more slowly, some orchards may last 50 years or more. On the other hand, in sections where the tree develops more rapidly, orchards of 35 to 40 years have frequently passed the time for the most economical production of good-quality fruit. Thus, it would appear that most commercial orchards should be replaced at least by the time they are 40 years of age.

Fruit of the best size and quality is invariably produced on relatively young trees. Because of the height of large old trees it is difficult to spray them thoroughly and expensive to prune them and to thin and pick the fruit. The various fruit sections that have attained reputations for producing high-quality apples have invariably made these reputations while the orchards were relatively young.

The renewal of the orchard permits the planting of the best varieties and strains. Practically every orchard as much as 35 years old contains a number of varieties that would not be planted today, as they have proved their inferiority as commercial varieties. Also, such orchards do not contain some of the newer varieties that have proved outstanding in recent years.

Thus, the apple orchard must be systematically renewed if good-quality fruit is to be produced. Instead of maintaining orchards to as old an age as possible, new acreage should be systematically planted to replace the old, or old orchard sites should be replanted. If orchards are replaced at not more than 35 to 40 years of age, the trees can be planted somewhat closer together, production per acre can be increased somewhat during the principal producing life of the trees, and the best varieties and strains can be more quickly incorporated in the planting.

On an average, about 6 to 8 years is required before appreciable production is obtained on apple trees in most parts of the United States and from 8 to 10 years before the orchard produces much tonnage. Thus about one-fourth of the life of the trees is required to bring them into good production. A grower who is systematically renewing his orchard will need to have approximately one-fourth of his acreage under 10 years of age in order to bring about such systematic renewal. In the United States as a whole about 12 million trees in this nonbearing or a very early bearing stage would be required to maintain 40 million trees of bearing age in orchards. This bulletin deals with the selection of orchard sites, planning and planting the orchard, and care of this nonbearing orchard acreage.

SELECTION OF SITES FOR ORCHARDS

SITE FROM THE STANDPOINT OF FROST INJURY

Too much emphasis cannot be placed on the importance of air drainage from the standpoint of apple production. In most parts of the United States spring frosts or freezes shortly before, during, or after bloom constitute a tremendous hazard in apple production. This hazard can be reduced by selecting the most favorable sites for orchard planting, although in most parts of the United States it cannot be entirely eliminated.

It is a well-known principle that cold air is heavier than warm air and that cold air tends to settle into the low spots. Thus on still, frosty nights the temperature in valleys or depressions surrounded on all sides by higher land may be many degrees colder than that in more elevated locations. Under such conditions a difference of 100 feet in elevation may make a difference of 5° to 10° F. in the minimum temperature encountered. In many seasons such differences would mean the difference between a full crop and a crop failure. Thus, the first prerequisite of a site for the apple orchard is that it be sufficiently elevated so that the cold air can settle below rather than into the orchard.

Sites above good-sized streams or lakes, with free opportunity for the cold air to settle from the orchard to the water are particularly favorable from the standpoint of frost protection. Timber surrounding the lower side of an orchard may tend to pocket the cold air

and result in a frost pocket, even though the slope of the land is away from the orchard.

Although it is desirable that the orchard be located on a site sufficiently elevated to secure good air drainage, sites on the tops of ridges may be unsatisfactory from several standpoints. Such sites are exposed to heavy winds, which at times may do much injury to trees and fruits; also, wind may interfere with spraying at the proper time. Exposure to very cold winds in winter may increase the hazard of low winter temperatures. The slopes along the sides of ridges are frequently more desirable than the tops.

The location of the orchard on a very steep slope offers a number of problems in the later management of the orchard. On such steep hillsides spraying is a serious problem. This can be handled by installing a central stationary spray plant and piping the orchard for

FIGURE 1.—Apple orchard on a rather steep hillside. Frost rarely reduces the crop on the trees in the upper two-thirds of the orchard, but frequently it reduces or destroys the crop on the lower trees.

spraying. Cultivation of steep hillsides may be impracticable because of the danger of erosion. Fortunately the apple thrives well under permanent or semipermanent sod systems. Consequently, if the soil is satisfactory, apple orchards can be planted on steeper slopes than would be satisfactory for most other fruits. Many orchard operations, such as pruning and thinning, harvesting, and hauling of the fruit, are more difficult on steep hillsides than on more nearly leval land. However, the excellent air drainage usually found on such sites may more than compensate for the problems in management. Thus, many successful apple orchards are located on slopes of as much as 20° to 30°. Figure 1 shows such a location, where most of the orchard has excellent air drainage.

SITE FROM THE STANDPOINT OF SOIL

A second and equally important consideration in determining where the orchard should be located is the soil. Establishing and maintaining an orchard to bearing age is very expensive, costing in most parts of the United States from $200 to $400 per acre. Many orchards have been planted on soils so shallow or so poor that an intelligent examination of the soil would have shown at the start that there was no chance for the orchard to prove successful. The old idea that soil unfit for other use is satisfactory for an orchard has been costly to many growers. Soils may be too steep or too stony for general farm crops and still be well adapted to orchards. However, the heavy investment necessary for establishing an orchard should not be made on a soil that is not certain to be satisfactory for the purpose.

The most important factors to consider in the soil are: (1) Drainage and aeration; apple orchards usually are not successful on soils that become waterlogged and remain in that condition for any appreciable length of time, particularly during the growing season; (2) water-holding capacity; this includes a consideration of both the texture of the soil and its depth; (3) capacity to absorb water readily from rain or irrigation; and (4) fertility.

Soil Drainage and Aeration

In many soils the subsoil is so heavy and impervious to water movement that the water does not drain out of the ground freely. In such soils the spaces between the soil particles become completely filled with water during wet seasons. This water excludes the oxygen of the air, which is essential for root growth and, in fact, for maintenance of life in apple roots. Thus, apple roots will not grow in a soil that is waterlogged. If the soil has been drained for a period of time and root development has occurred, a period of waterlogging of any considerable duration while the trees are in active growth will result in the death of the roots. The roots can stand some submergence during the dormant period, provided the water drains away by the time growth starts in the spring. Submergence of the root system for even a few days during the summer growing season, when temperatures are high, usually results in the death of the roots.

Consequently, in soils that tend to be waterlogged the root system of apple trees is usually confined to the relatively shallow surface layers of soil. Although the tendency to become waterlogged is greater in the heavier types of soils, even soils that are sandy and porous on the surface may have a tight subsoil that prevents the drainage of excess water. Poor drainage can frequently be detected by an examination of the subsoil. Poorly drained subsoils in many cases are mottled in color, with prominent gray streaks and rusty brown spots, which indicate a lack of adequate aeration. Unless it is clear that the soil is well-drained, the putting down of test holes to determine whether standing water is present and how long it stands in such holes in the spring may be highly desirable. If it is found that water stands within 3 to 4 feet of the surface in such test holes for a period of several weeks after growth starts in the spring, the site is undesirable for orchard purposes.

Even in soils free of standing water, root development is usually sparse and slow in fine-textured soils with limited air space. Both root growth and top growth of trees are more rapid in open-textured than in fine-textured soils, provided moisture is ample. Thus the ideal fruit soil is one having a moderately open texture but sufficiently deep and well-drained to permit deep rooting. Although available water-holding capacity per foot of depth (see below) is less in moderate- than in fine-textured soil, this lack is compensated for if the moderate-textured soil is of somewhat greater depth. Thus, moderate-textured soils of good depth and drainage are ideal for apple production.

Water-holding Capacity of Soils

Any soil will hold a certain amount of water against the force of gravity, which causes the free water in the soil to move downward. The amount of water the soil will hold against gravity is known as the field capacity. It cannot be changed appreciably by any cultural operation. The building up of organic matter in the soil will tend slightly to increase its capacity to hold water, but this is generally limited to a few inches on the surface. Organic matter in the soil is more important from the standpoint of improving water penetration than from that of actually increasing the water-holding capacity of the soil.

In general, the finer textured the soil the greater the amount of water it will hold per foot of depth. An open sandy soil will usually hold water not in excess of 10 percent of the weight of the soil. A finer silt-loam soil, on the other hand, may hold 20 to 25 percent of its weight in water. Heavy clay soils may hold as much as 30 to 35 percent of their weight in water, although such fine soils are likely to be poorly drained, and this is not satisfactory for tree growth, as discussed on page 4.

Not all the water that a soil will hold is available for plant growth. A certain residue cannot be extracted from the soil by plants. In most soils only about half or a little more of the total water the soil will hold is available for plant growth. The amount of water in the soil at the time plants can no longer extract sufficient water to prevent their wilting is known as the wilting percentage of the soil. The amount of water between the field capacity and the wilting percentage is referred to as available water, or the amount of water available for plant growth.

A sandy soil that has a field capacity of 8 percent is likely to have a wilting percentage of 2 to 4 percent, and the available water would equal only 4 to 6 percent of the weight of the soil. In a layer of soil a foot deep, 6 percent of moisture corresponds to a layer of water approximately 1 inch deep over the soil surface, or the amount that would fall in 1 inch of rain. Thus, such a sandy soil 4 feet deep would store up, available for the trees, only 3 to 4 acre-inches of water. In contrast, a good silt-loam soil with a field capacity of 20 percent and a wilting percentage of 8 would store 2 inches of available water for each foot of depth. For this reason, the sandier types of soils are suitable for apple-orchard planting only when deep and well-drained. Approximately twice the depth of soil is necessary in a medium sandy soil that would be necessary in a silt-loam soil to carry the trees through

the same period of drought or the same interval between irrigations.

During the summer months mature apple orchards will use about 4 acre-inches of water per month. Thus, if the soil will hold 8 acre-inches within the root zone of the trees, rainless periods of 6 to 8 weeks will not be very serious. In nonirrigated orchards such a soil will provide adequate insurance against serious drought hazard in those parts of the country where total annual rainfall exceeds 35 inches. In soils holding less than about 8 inches of available water within the root zone, drought hazard is high, particularly in the warmer parts of the country. Even under irrigation, soils of such water-holding capacity are highly desirable, as the intervals between irrigations can be longer than on soils of limited water-holding capacity.

Water Penetration Into Soil

Good fruit soils take up water readily. This is equally important, whether the orchard is to be maintained under irrigation or under natural rainfall. In soils that take up water very slowly, the run-off is likely to be heavy during periods of rain. This not only results in erosion, but, what is equally serious, the water is lost to the orchard instead of being available to the trees. The problem caused by the nonpenetration of water into the heavy impervious soils makes irrigation difficult in many orchards. Therefore, a soil sufficiently open to absorb rather rapidly the rainfall or irrigation water is highly desirable. The maintenance of adequate organic matter in the surface soil greatly increases water penetration.

Soil Fertility

In general, the characteristics of the soil in regard to water-holding capacity, water penetration, and aeration are more important from the orchard standpoint than is the question of fertility. Most soils in the United States are well supplied with the plant-food elements necessary for tree growth, except for nitrogen. Nitrogen can be added rather readily in the form of commercial fertilizers. Other elements occasionally lacking in orchard soils, such as potassium, boron, and zinc, can also be supplied. Thus, the actual fertility of the soil is relatively less important than its physical characteristics and its location or site.

PLANNING AND PLANTING THE ORCHARD

PLANNING THE ORCHARD

The planting plan for the orchard should be based on the site and on the management practices to be followed. Where ample moisture is usually available, from either irrigation or natural rainfall, and where soils are of good depth and texture for apple production, apple trees can be grown very satisfactorily with the areas between the trees in permanent or semipermanent sods, but the areas immediately around the trees should be cultivated or mulched while the trees are young. Where the orchard can be maintained in such sods, the problems of erosion control are largely cared for by the maintenance of such sods on the surface of the soil. Thus, where such sods

are maintained, orchards even on relatively steep slopes are not seriously affected by erosion, and special planting plans for erosion control are not necessary.

In sections of the country where the annual rainfall is less than 35 inches per year and where irrigation is not feasible, it is essential that all of the water that falls be absorbed by the soil, not only to prevent erosion but also to provide sufficient water for the trees. Also under such conditions it may be desirable to practice partial cultivation with cover crops in order to reduce the competition between the trees and the cover crops for the limited water that is available. If cultivation is to be practiced in the orchard, particularly through very much of the growing season, it is desirable that the trees be so planted that erosion will be reduced to the minimum. This means planting the trees on the contour or with all those in a row at the same level in the orchard, either with or without the construction of definite terraces at the point of tree planting. These factors must of necessity be considered in laying out the orchard.

Where conditions appear satisfactory for maintenance of good sod covers in the orchard, the square or the rectangular system of planting is usually in greatest favor. In the square system, trees are planted at equal distances from one another in rows running in two directions. In the rectangular system the trees are planted somewhat closer together in one direction than in the other. Thus, for example, the trees might be planted 30 feet apart in the row, with rows 40 feet apart. The latter system has the advantage of providing greater space between the rows in one direction, which facilitates getting through the orchard for spraying, hauling of fruit, and other operations, particularly after the trees have attained large size.

Where erosion is likely to prove a factor and where the orchard is to be maintained under cultivation, the planting of the trees on the contour on sloping ground has much to recommend it. It is necessary to establish the levels in the orchard and lay out the tree rows in such a way that all trees in a row are in soil at the same elevation. Thus the rows are not straight but run around the slopes of the hills in such a way as to maintain an approximate level for the trees in any row. Under such planting conditions, cultivating should be done entirely between the rows planted on the contour, and not up and down hill. Cultivation under these conditions tends to build slight ridges at the tree row, which reduce the tendency of the water to run down the slope and thus increase absorption. In time, natural, rather low terraces result from such contour planting coupled with contour cultivation. Obviously the tree rows are not equally spaced in all parts of the orchard. On the steeper slopes the rows would tend to be closer together, while they would be farther apart on the less steep areas. An orchard laid out by the contour system is shown in figure 2. On steeper parts of the orchard it may be necessary to drop out parts of rows in order to prevent their coming too close together.

The third method of planting involves the construction of actual terraces prior to the planting of the trees. The site is terraced as for other farm operations, by throwing up along the contour ridges sufficiently high to impound the water above them. The trees are

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planted on the ridge of soil thrown up to form the terrace. On gentle slopes it may not be necessary to build a terrace for each tree row. In that case the intermediate tree rows not on terraces are on the contour, and natural terraces tend to develop, as indicated above. Since the terraces are built mainly of topsoil, growing conditions on such terraces are usually very favorable for the young trees. Figure 3 shows an orchard with a few terraces and with the remaining tree rows on the contour.

Terraced apple orchards have the disadvantage that the terraces are difficult to cross with equipment in spraying, hauling fruit, etc. Consequently, such plantings of orchards have been followed but rarely

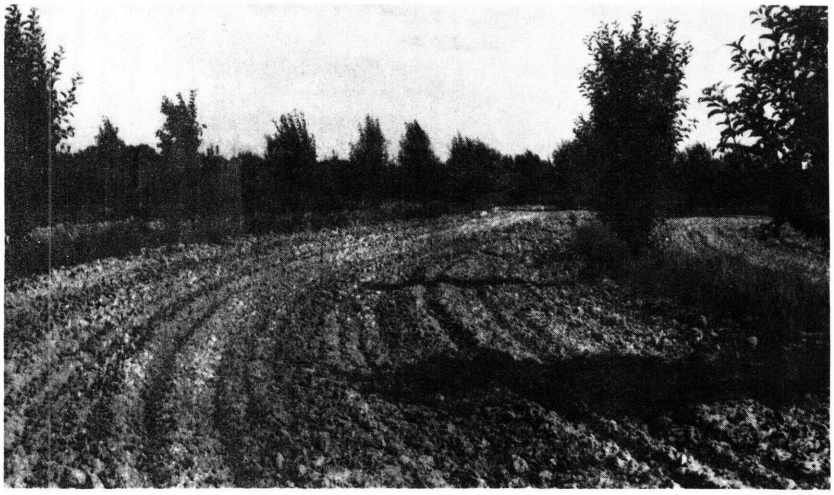

FIGURE 2.—An orchard planted on the contour, showing cultivation that results in building low terraces in the tree rows. (Courtesy of the Soil Conservation Service.)

with apples, where permanent sods and mulches can be used to control the erosion.

SPACING THE TREES

The proper distance for setting the trees will vary with the variety, with the fertility and water-holding capacity of the soil, and with the plan to thin the stand of trees as they attain large size. It is not possible to grow good-quality apples where the fruit is almost permanently shaded. The trees must be sufficiently far apart to allow the sun to hit the lower branches, if fruit of satisfactory quality is to be grown on the lower parts of the trees.

The age at which trees planted a given distance apart will begin to crowd will vary with the fertility of the soil and the inherent vigor of the tree. Thus trees of vigorous varieties, such as Baldwin, McIntosh, and York Imperial, planted 25 feet apart in strong soil, may crowd when only about 12 years of age; planted 30 feet apart they will usually crowd when about 20 years of age. Less vigorous trees such as Rome Beauty, Winesap, and Golden Delicious, planted 25 feet apart, would not crowd seriously until 16 to 18 years of age.

If trees are planted on the square 25 feet apart, diagonal rows can be removed later, leaving the trees approximately 35 feet apart. Trees planted 28 feet apart on the square would be 39.6 feet apart after the removal of the diagonal rows. If trees are originally planted 30 feet apart, the distance will be 42.4 feet after taking out the diagonal rows, a desirable distance for strong-growing varieties on good soil. Thus for a permanent planting distance of 35 feet, the trees should be planted approximately 25 feet apart if it is planned to thin the orchard. With more vigorous trees, planting 28 feet apart will permit thinning to a distance approximately 40 feet each way. Many orchards planted 32 to 34 feet apart have presented a serious problem as they grew older, because they crowd seriously at that distance and any tree removal leaves the trees too great a distance apart for greatest

FIGURE 3.—Aerial view of an orchard with a few terraces constructed prior to planting trees. The rest of the tree rows are on the contour. (Courtesy of the Soil Conservation Service.)

economy in operations. On most soils, about 35 feet as the permanent distance should be most satisfactory for moderately vigorous varieties, and 40 to 42 feet for the most vigorous ones.

Many growers prefer an unequal spacing of the trees, with wider distance between the trees in one direction than in the other. Thus, for vigorous varieties, they prefer to have the trees about 35 feet apart in rows in one direction and 45 feet in the other, rather than having them on the square at 40 by 40 feet. Such an arrangement has much to recommend it, because in the young orchard wide centers are available in one direction for intercropping, and in the mature orchard there is greater space for spraying, hauling fruit, and other operations. Where such a system is used on sloping ground, it is preferable to have the more closely planted rows go across the slope

rather than up and down, as cultivation, hauling, and spraying up and down the slope may start erosion. Such a system does not lend itself to closer planting while the trees are young as readily as does planting on the square, but where orchards are initially set at what is planned to be the permanent distance, the plan has much to recommend it.

The desirability of closer planting while the orchard is young, with later removal of half the trees, depends largely upon how the land can be utilized for intercrops. If it is possible to produce crops that will return a revenue during the early years of the orchard, it may be better economy to plant the trees at the permanent spacing. On the other hand, if the soil is steep or broken or if for other reasons crops between the trees cannot be produced profitably, the orchard may well be more closely spaced and half the trees may be removed when crowding occurs. Trees planted 28 feet apart should produce at least 10 to 12 fruit crops before crowding becomes serious. The great danger in such a program is that all the trees will be allowed to remain too long in the orchard, and serious injury to the permanent trees from crowding will occur before the thinning is done.

ARRANGEMENT OF VARIETIES

No apple variety is sufficiently self-fertile to be dependably productive if planted alone. Some varieties will produce partial crops under these conditions, but for most dependable and uniform crop production, provision for cross-pollination must be made. Orchard observations and experimental results would indicate that to obtain the most dependable set of fruit, trees should not be farther than two tree rows, or 80 to 85 feet, from pollinizer varieties.

On the other hand, it is generally preferable to have all of the trees in one row of the same variety. This facilitates harvesting operations, and if special spray programs are desirable for particular varieties they can be applied better if varieties are planted in solid rows.

Where varieties selected are all good pollinizers, two varieties are sufficient for planting, from the standpoint of fruit set. On the other hand, if one variety is a poor pollinizer, as is the case with such varieties as Winesap, Stayman Winesap, Baldwin, Rhode Island Greening, and others, it is desirable to have more than two varieties interplanted in order to obtain an adequate set.

Where it is desirable to plant the bulk of the orchard to one variety, this can be accomplished by planting three rows of the major variety followed by one row of a pollinizing variety and then an additional three rows of the major variety. If the major variety itself is a poor pollinizer, it will be preferable to plant three rows of the major variety, followed by one row each of two pollinizing varieties. If the grower desires to keep the number of trees of pollinizing varieties to the minimum, the two pollinizing varieties can be alternated in one row, although this is not normally the best arrangement. Experience indicates that where the blocks of trees of a variety are more than three rows wide, trees in the interior rows tend to set fruit more sparingly than the trees next to the pollinizing varieties.

SELECTION OF NURSERY STOCK

In the United States, apple trees are generally propagated on seedling apple roots. Either imported seed from French cider apples or that from American varieties is planted and grown for a year in special nurseries. When these seedlings are 1 year old they are dug while dormant and sold to the fruit nurserymen, who plant them out a few inches apart in rows for later budding or use them for piece-root grafts.

When propagated by budding, these seedlings are budded to the desired varieties in July to September following their planting in commercial nurseries, or approximately 16 to 18 months after the seed was planted. The following spring the young trees are cut back to the variety bud before growth starts. This bud normally makes strong growth in the nursery row. At the end of 1 year these trees may be sold as 1-year nursery trees. Where the growth is not sufficient to form large trees in one season, as is frequently the case in northern nurseries, these 1-year trees are headed back and grown a second season in the nursery row; they are referred to as 2-year trees. Thus, the 2-year trees are normally larger and have heavier trunks than 1-year trees, and the tops are considerably branched. The additional year in the nursery, of course, involves additional cost to the nurseryman, as the so-called 1-year budded trees represent 1-year-old variety tops on 3-year-old seedling roots, and the 2-year budded trees represent 2-year-old tops on 4-year-old roots.

Either the 1-year or the 2-year trees are very satisfactory for orchard planting. Only No. 1 nursery trees of either age should be planted, as the No. 2 or smaller sized trees may be smaller because of inherently less vigorous roots. Where only trees that have made a uniformly good growth in the nursery are planted in the orchard, very uniform results can be secured, even though there is variability in the rootstocks on which the trees are grown. Apparently the trees on less vigorous roots are largely eliminated in the nursery row if only uniformly well-grown trees are planted.

Piece-root grafting is used instead of budding in apple propagation to a large extent in the Middle Western States and to a limited extent elsewhere. With this method short sections of roots, usually 1 year old, are dormant-grafted to long scions and lined out in the nursery with only one or two buds above ground. Usually such trees are 2 years from grafting when offered for sale. Cold-resistant varieties, when piece-root-grafted, have their seedling roots, which may be relatively tender, deeper in the ground and thus better protected from cold than when budded. Often roots form from the scion, which is an advantage if the scion is cold-resistant. Hardy scions may be worked on such piece roots, planted in the orchard, and later top-worked, preferably in the main branches, to more tender but better quality varieties. Hibernal crab, in the colder parts of the Middle West, has given outstanding results in such intermediate trunk and crotch varieties. Where such intermediate hardy varieties are used or where the permanent scion variety itself is especially cold-resistant, piece-root grafts appear preferable to budded stock. For sections where special resistance to low temperatures is not required, however, budded stock appears fully as satisfactory as root-grafted stock for general orchard use.

TIME OF PLANTING

In the milder parts of the United States where minimum temperatures are not likely to go below 0° F., apple trees may be planted at any time the ground is unfrozen during the late fall, winter, or early spring. In the colder sections late-fall or early-winter planting may result in winter injury.

The roots of apple trees are more tender to cold than other portions. Exposed apple roots may be killed by temperatures of 20° to 24° F. If nursery trees are being handled in winter, it is necessary to use great care to prevent cold injury to the roots.

New root development will occur when the soil temperature is above 45° F. Spring planting, therefore, should be completed as soon as possible after frost is out of the ground, in order to allow some root development by the time top growth starts. If planting is done in the very early spring, trees will grow about as well as after fall or winter planting. In general, the later in the spring the trees are planted the poorer the growth response will be, because of the poor establishment of the new root system when top growth begins.

METHOD OF PLANTING

It is desirable to dig a hole somewhat deeper and larger than necessary to take in the root system of the tree. Any broken or injured roots should be trimmed off, but in general the root system should not be reduced more than necessary prior to planting. The roots of nursery trees contain much stored nitrogen and other plant foods, which are used in forming both new root growth and new top growth.

The tree should usually be set at approximately the same depth as it was grown in the nursery. Planting the trees too deep should be avoided, particularly in heavy or rather poorly drained soil. In very dry areas, however, it may be desirable to set the trees somewhat deeper than they were in the nursery in order to have the roots in contact with moist soil.

Where distinct soil layers occur and the surface soil is more fertile than the subsoil, it is desirable that surface soil be filled in around the roots. In heavy soils better root development and better growth have been obtained when well-soaked peat moss was mixed with the soil surrounding the roots. The fact that such benefit has usually not occurred in lighter soils indicates that the beneficial effect is generally due to aeration. It is known that good aeration is essential for the best development of apple-tree roots. If peat is used, it should be soaked in water until thoroughly wet, as dry peat will take up water only very slowly from the soil.

The soil should be packed firmly around the roots in order to establish good contact. If the planting has been done a month or 6 weeks before top growth would normally begin, the young roots should have pushed into the soil before much top growth starts. In most sections there will be ample moisture in the soil at the time the planting is done; but should the soil be dry, the soil surrounding the roots should be soaked after planting.

SOIL MANAGEMENT IN YOUNG ORCHARDS

Although mature apple trees will thrive well in permanent grass or other sod culture, young trees should be protected from competition with other vegetation until they are well-established. The roots of young apple trees are no deeper in the soil than the roots of grass or weeds, and if such plants are permitted to grow near the trees they will compete with them for water and nutrients and greatly reduce their growth rate. Thus, it is essential that the soil be so managed as to prevent the competition of other vegetation near the trees during the first few years they are in the orchard. This is most commonly accomplished by cultivation, either with or without the use of intercrops between the tree rows.

CULTIVATION, COVER CROPS, AND INTERCROPS

Probably the most widely used method of handling apple orchards during the first few years is cultivation of the whole area between the trees, with seeding of cover crops in midsummer to late summer. These cover crops should be allowed to grow until the growth on the trees is well started in the spring. They are then disked into the soil and the orchard cultivated just enough to prevent excessive weed growth during late spring and early summer. In July or early August a new cover crop is planted. None of the organic material grown in the orchard is removed, and there is no income from the land until the trees begin to bear. The cover crop should be fertilized if necessary to promote good growth.

Such a system of handling is very satisfactory from the standpoint of tree growth. Where trees are interplanted with so-called filler trees, which make a minimum distance between the trees while the orchard is young, the system of using cover crops is generally more satisfactory than attempting to grow intercrops between the tree rows, since the area that could be devoted to intercrops between each two tree rows would be relatively narrow.

In most parts of the United States rye is particularly satisfactory as a winter cover crop. It is so hardy that it is rarely winter-killed, and it forms a heavy top growth and a surface mat of roots, which is very effective in reducing erosion. Where winters are not too severe, a mixture of vetch and rye is very satisfactory. Where the rye grows close to the young trees, it should be disked under by the time it heads and before the straw becomes too dry. On the other hand, maximum organic matter is added to the soil if the rye becomes ripe before being disked in. A good system for young apple orchards is to disk next to the trees by the time the rye heads, and to allow the rye in the centers away from the trees to ripen before disking, as the riper rye is much more valuable for increasing the organic-matter content than that disked in while still green and succulent. Seeding should be done early enough in the summer to insure a dense cover on the soil before cold weather stops growth.

Where a heavy cover crop is incorporated into the soil each spring, the loosening of the soil and the additional organic matter that result tend to reduce greatly the amount of erosion. On moderately steep

slopes, however, and particularly in areas where heavy summer rains may occur, cultivation during the early summer may result in too much washing to be satisfactory, even though heavy cover crops have been disked in. Under such conditions permanent sods with strip cultivation along the tree rows, or mulching around the tree, as discussed subsequently (p. 15), is more satisfactory.

Frequently a young orchard, if on a fairly level site and in good soil, can be interplanted for a few years with cultivated crops, such as potatoes, peas, beans, cabbage, and strawberries. Where such crops are used, it is desirable not to have the rows nearer than 5 to 6 feet from the tree rows during the first 2 years, with increasing distance as the trees become older. The areas between the tree rows and cultivated crops should be kept cultivated during the spring and early summer. If the site and soil are such that erosion does not occur, tree growth under such conditions is usually very satisfactory.

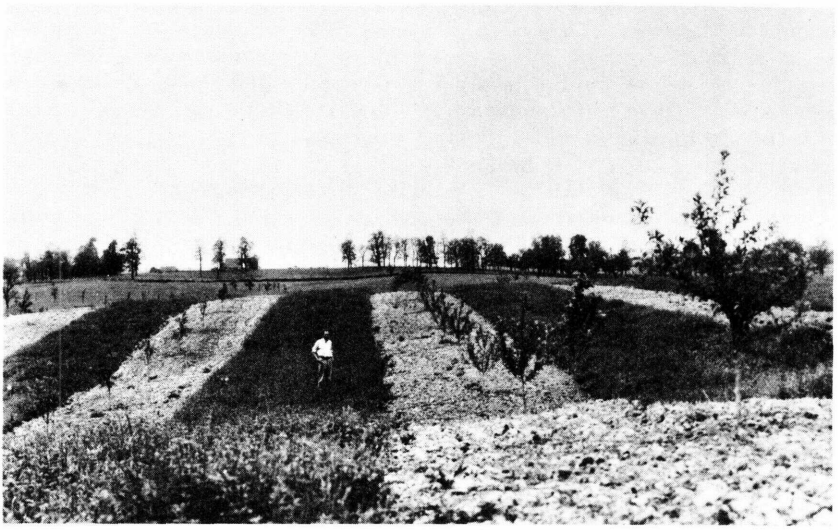

FIGURE 4.—Wide cultivated strips adjacent to tree rows in young apple orchard. Center strips, alfalfa.

This is particularly true if cover crops and fertilizers are used to maintain the fertility of the soil.

In many parts of the country alfalfa, clover, or grass may be grown to excellent advantage between the young trees. With these crops also, in order to maintain growth, it is desirable that strips adjacent to the trees be kept cultivated or that other provision be made to prevent competition close to the tree. With such sod crops the cultivated strip on each side of the tree rows should be at least 5 to 6 feet wide during the first 2 years and should be gradually widened as the trees become larger. Such strip cultivation should be continued until the trees reach bearing age; after that, shading is usually sufficient to prevent heavy growth of the sod crop near the tree trunks.

Occasionally the Buffalo and other tree hoppers may injure young trees when alfalfa or clover is grown in the orchard. These crops are favorite hosts for the tree hopper and large populations may build up

in them. The hoppers then may severely puncture young branches of fruit trees in egg laying. Such damage rarely occurs if the alfalfa and clover are kept well away from the young trees.

MULCHING

An alternative to cultivation along the tree rows in young orchards is mulching around the trees with straw or other vegetable matter.

FIGURE 5.—Heavy straw mulch around a tree in a young orchard in alfalfa-sod culture.

To be effective, such mulches must be heavy enough to prevent the growth of weeds or other vegetation around the tree. They should cover an area extending at least 3 to 4 feet out from the trunk during the first 2 years and continuing out to beyond the spread of the

branches as the trees increase in size. Such mulches should be 6 to 8 inches thick when applied and should be renewed often enough to keep down competing vegetation. Where such mulching material is used, the growth of the trees usually is as good as under cultivation. Figure 5 illustrates the use of mulch around young trees.

In orchards maintained in grass or legume sods, frequently ample mulching material can be obtained by mowing, raking up the mowed material, and piling it around the trees. On strong soil, only a part of the material grown in the orchard is necessary to maintain such a mulch, and the remainder may be used as feed without injury to the development of the orchard.

Under mulches there is a tendency for an abundant development of roots near the surface of the soil. There is no evidence, however, that the tree as a whole is more shallow-rooted under mulch than under other methods of soil management, as many roots will also penetrate down into the soil if it is sufficiently open, regardless of the type of surface treatment. Mulching is particularly satisfactory for orchards located on steep slopes or in rocky soil where cultivation is difficult or likely to cause erosion. It is also an economical method of treatment under many other conditions.

Where mulches are used, particular precaution must be taken to control mice, which tend to harbor under the mulches and may eat the bark from the tree trunk and roots. In early fall the mulch should be removed from immediately about the trunk of the tree back for a distance of at least a foot and a half. Also, if mice are present, systematic poisoning or other control measures should be practiced.

Hand cultivation immediately around the trees may be used instead of strip cultivation or mulching, under conditions where the orchard is maintained in sod and strip cultivation or mulching is not used. Such a system involves much hand work, as competing vegetation must be kept down for a distance of several feet from the tree, and working at least two or three times each season is desirable.

FERTILIZATION

In most parts of the United States nitrogenous fertilizers should be added to promote the best growth of the trees. In a few locations, particularly on rather heavily leached soils, potassium may become a limiting factor in the growth of the trees. Under most conditions, however, nitrogen appears to be the only fertilizer material required to give ample growth.

The amount that should be applied will, of course, vary with the age of the tree and with the management practices being followed. It is usually undesirable to add mineral fertilizer before the tree has become established and started growth. A quarter to a half pound per tree, of such materials as nitrate of soda or sulfate of ammonia scattered over an area within 3 feet of the trunk and applied after growth has started in the season of planting, will usually prove beneficial. This amount may be increased as the tree grows older, about one-third pound per tree for each year of age of the tree usually giving satisfactory results. If mulches are being used, the quantity of nitrogen can be reduced as the mulch begins to decay. On the other hand, if grass or other sods are growing near the tree, the amount of nitrogen should be increased.

In general, on soils tending to be alkaline, the acid-forming nitrogenous fertilizers, such as sulfate of ammonia, are preferable. On the other hand, on acid soils the forms of nitrogen that leave an alkaline residue, such as nitrate of soda or calcium nitrate, are to be preferred.

The objective in soil-management practices during the early life of the orchard should be to maintain or build up the organic-matter content of the soil, to prevent erosion, and to maintain as much available moisture as possible for the growth of the tree. The more rapidly the tree grows during the early years of its life, the earlier it will come into production and the greater the amount of fruit it will produce at a given age. The growing of cultivated intercrops will tend to deplete the organic matter rather than to increase it unless these crops are coupled with overwinter covers, which are turned into the soil. On the other hand, maintenance of the orchard in sod with strip cultivation or mulching around the trees will tend to increase the organic-matter content of the soil and improve the basic fertility. Cultivation of the whole area during early summer, followed by turning a good cover crop into the soil in the spring, should maintain and in most cases increase the total organic matter in the soil.

PRUNING

The purpose of pruning young nonbearing trees is primarily to shape the trees so that the main scaffold branches will be well distributed up, down, and around the trunk. This is the surest way to avoid bad crotches, which may result in breakage later in the life of the tree. Careful selection of the best scaffold limbs early in the life of the tree should make it possible to avoid most large cuts later and thus reduce the hazard of the entrance of wood-rotting fungi into the older trees.

In general, this early shaping of the tree should be accomplished with the smallest possible amount of pruning. Much experimental work has shown that the more severe the pruning of the tree prior to bearing age, the more production is delayed and the smaller the tree will be at any given age. Trees that receive little pruning from the time of setting until they reach bearing age are almost invariably larger and fruit earlier than heavily pruned trees of the same age. Thus, since pruning tends to be a dwarfing process and to delay bearing, shaping of the tree during its early life should be accomplished with the minimum amount of cutting.

Pruning the tree during the first 4 or 5 years it is in the orchard is more important from the standpoint of determining its structure and strength than any later pruning. From the time the tree is started, it is necessary for the grower to have in mind the general type of tree that will have maximum strength in the framework branches and will support a crop of fruit with least breakage.

At the beginning of the twentieth century the so-called open or vase-type tree was much in favor. In building this type of tree the main scaffold limbs were taken from near one point on the trunk. The natural central leader of the tree was removed, and several more or less equal limbs were developed. It was thought that this type of tree would expose the maximum fruit surface to light and thus improve the quality.

FIGURE 6.—A nearly ideal trunk and branch development in an apple tree just beginning to bear fruit.

It was found, however, that such trees were very weak structurally, since the scaffold limbs originating at one point tended to form crotches that split apart when heavy loads of fruit developed; also, heavy pruning was required to maintain the tree in this form, and the total bearing capacity was reduced. Consequently, in more recent years apple trees have been pruned almost exclusively to the leader or modified leader type. This gives a stronger tree structurally with greater bearing capacity. Most of the fruit in any case is borne on the outer part, or periphery, of the tree, so that the crop is as well exposed to light with this type of tree as with the vase form. Only the modified leader or the leader tree is discussed in the following paragraphs.

By the leader type of tree is meant one in which a central trunk is maintained. In all cases the limbs branching off from this main leader should be smaller at the point of union than the leader branch. Such a union has been found to give the strongest possible type of crotch.

Also, the wider the angle made by the side branch from the central leader, the stronger the resulting crotch. Branches making narrow angles tend to split out, whereas branches from a larger leader, making wide-angle crotches, almost never split. Such branches may break from a heavy load of fruit, but they do not split out from the main trunk.

The ideal tree is also one in which only one side branch develops at the same height on the trunk of the tree. If the main side branches develop along the trunk at points at least 6 inches and preferably 10 to 12 inches apart, the strongest possible tree will develop. In addition to a good distribution along the trunk, main limbs should be as well distributed as possible around the trunk. It is necessary that the pruner visualize how the tree will look, not when it is young but when the main side branches have developed to 3 to 6 inches in diameter. If this point is kept in mind, the necessity for selecting branches well-spaced along and around the trunk will be appreciated. A nearly ideal framework for an apple tree is shown in figure 6.

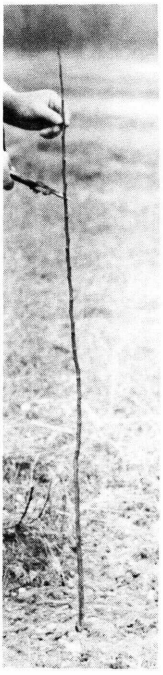

FIGURE 7.—A 1-year Stayman Winesap apple tree being pruned immediately after being planted.

PRUNING YOUNG TREES

When the young tree is received from the nursery it may be an unbranched whip 4 to 6 feet high. This is the most usual condition if trees 1 year from the bud are planted. Certain varieties, such as York Imperial, may have well-developed side branches even on 1-year trees; 2-year trees from the nursery usually have a number of side branches when received.

One-year whips should be headed at about 3½ to 4 feet when planted (fig. 7). If left longer, they are likely to blow in the wind unless staked; if headed lower, the branches will grow mainly from near the top of the short trunk that is left and will be close together. A good selection of well-distributed main branches will not be possible

after low heading. If side branches have developed in the nursery so that some of them are suitably spaced for scaffold limbs, they should be left on the tree when it is planted and all others should be removed.

The trees can be allowed to grow during the first year in the orchard with no further pruning until the following dormant season. During the winter following one growing season in the orchard, the important selection of scaffold branches must be made.

If the tree has been headed at 3½ to 4 feet high and has made good growth, 6 to 12 fairly strong side branches should have developed.

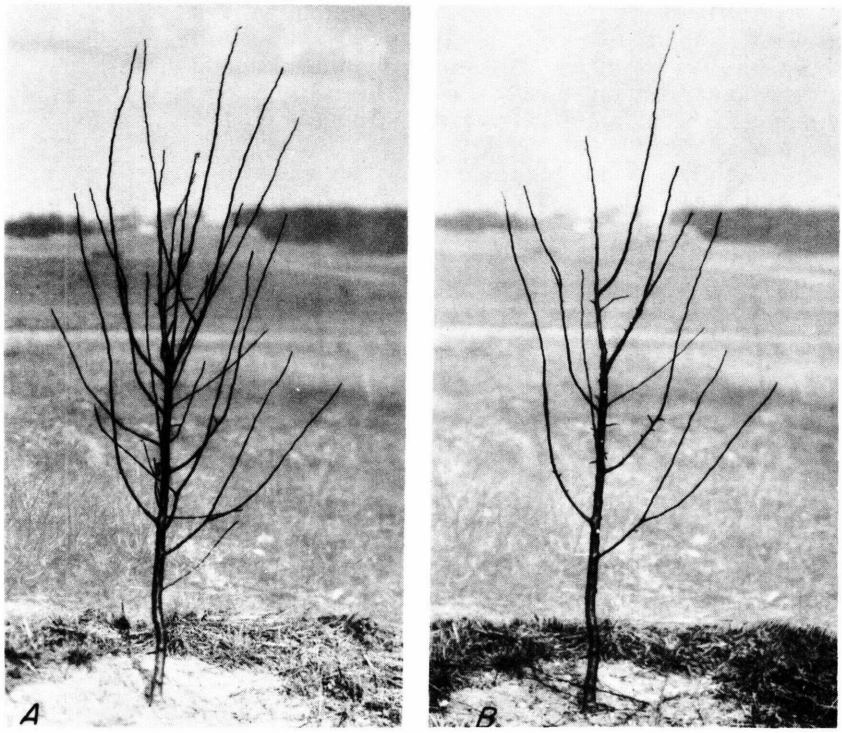

FIGURE 8.—A vigorous Delicious apple tree, grown 1 year in the orchard: *A*, As it appeared before pruning, showing an ample distribution and number of branches from which to select scaffold limbs; *B*, after pruning. The principal scaffold limbs were all selected at the end of the first year.

Usually those coming from the upper part of the tree make the strongest growth. If a good branch has developed from 1½ to 2 feet above the ground, it can be selected as the bottom scaffold limb. Two or three additional limbs spaced 6 to 12 inches apart (preferably the latter) along the trunk and extending in different directions from the trunk should be retained. The upright branch that is retained for the leader should be the strongest growing of all.

It is not necessary, and in most cases not possible, to select all the main scaffold limbs at the end of the first growing season. During the

second year the terminal branch that is left will produce additional strong laterals, which in turn can be used for additional scaffold limbs. Figure 8 shows a strong growing tree of the Delicious variety after 1 year in the orchard, before and after pruning to a modified leader type of tree. Enough well-distributed branches were available to make a good selection of scaffold limbs. Figure 9 shows a tree in which the branches rose too close together on the trunk to make possible the selection of all the scaffold limbs at the end of the first year in the orchard. Additional ones on the leader had to be selected at the end of the second year in the orchard.

Unless the tree is making exceptional growth, no heading of the branches or leader is necessary or desirable. Shoots making growth of 3 to 4 feet or more may require light heading back to prevent too much blowing and whipping in the wind.

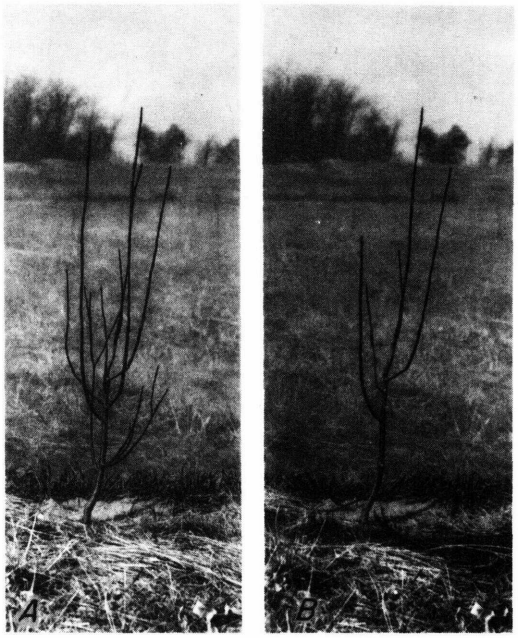

FIGURE 9.—Apple tree 1 year old in the orchard: *A*, Before pruning; *B*, after pruning. Branches developed too close together to permit full selection of scaffold limbs at the end of the first season in the orchard. Additional scaffold limbs had to be selected at the end of the second growing season.

DISBUDDING AND DESHOOTING YOUNG TREES

A number of investigations have been conducted to determine the value of selecting buds from which scaffold limbs are to be developed at the time the young nursery tree is set in the orchard and rubbing off the remainder of the buds so that only limbs desired as scaffolds would develop during the first season in the orchard. Experimental results have shown that with a limited number of branches growing during the first year, the angle at which such branches join the trunk of the tree is much narrower than where a larger number of buds are allowed to grow. This is particularly undesirable with trees naturally tending to grow upright. Also, the total growth of the tree during the first year is likely to be less with the smaller number of growing buds, although the growth from the individual buds remaining is as great, or possibly greater, after a disbudding treatment. Mainly because of the narrower crotches, this system has not come into general favor for apple trees.

A modification of this method is referred to as deshooting. In this treatment the young shoots are allowed to grow 2 or 3 inches, then

the selection is made and those not desired for scaffold limbs are cut off close to the trunk. Results from this are intermediate between disbudding and allowing the whole number of buds to develop into branches. Crotch angles are wider than after disbudding, but generally they are narrower than if a large number of branches develop. In some cases disbudding or deshooting has been followed by using mechanical spreaders to insure wider angles at the crotches. Excel-

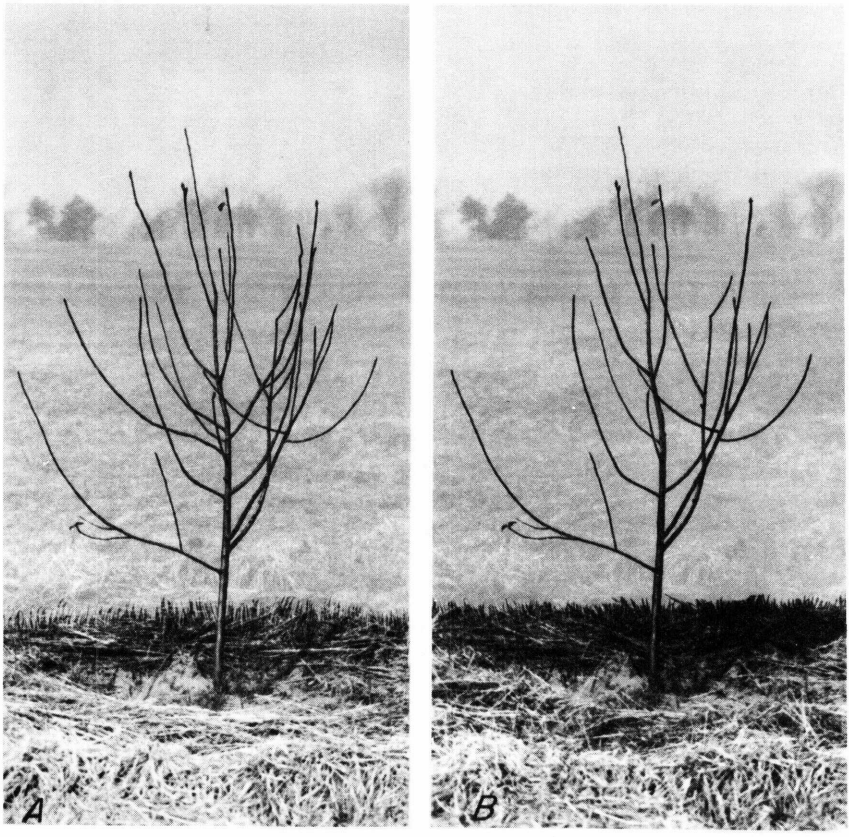

FIGURE 10.—A 2-year-old Jonathan tree: *A*, Before pruning; *B*, after pruning. A good selection of branches was made at the end of the first season. Very little pruning was required at the end of the second year.

lent trees can be built by this system, but it requires a great deal of detailed attention; and in the case of apples it is not greatly superior to allowing the competing buds to develop during the first season and making the selections of limbs at the end of the first year.

PRUNING TREES FROM 2 YEARS OF AGE TO BEARING AGE

Figures 10 to 14 illustrate pruning treatments for trees 2, 3, and 4 years of age. If a good selection of branches for scaffold limbs has

been made during the first 2 years, pruning during later years will consist mainly of removing undesirable sucker growth and of slightly thinning the top. Where two branches may be making sharp and even crotches, this condition should be corrected either by removing one of the branches or by suppressing its growth through heavier pruning on one branch than on the other. With competing branches as with trees, pruning is a dwarfing process, and the more heavily pruned branch will make less growth the following year than the

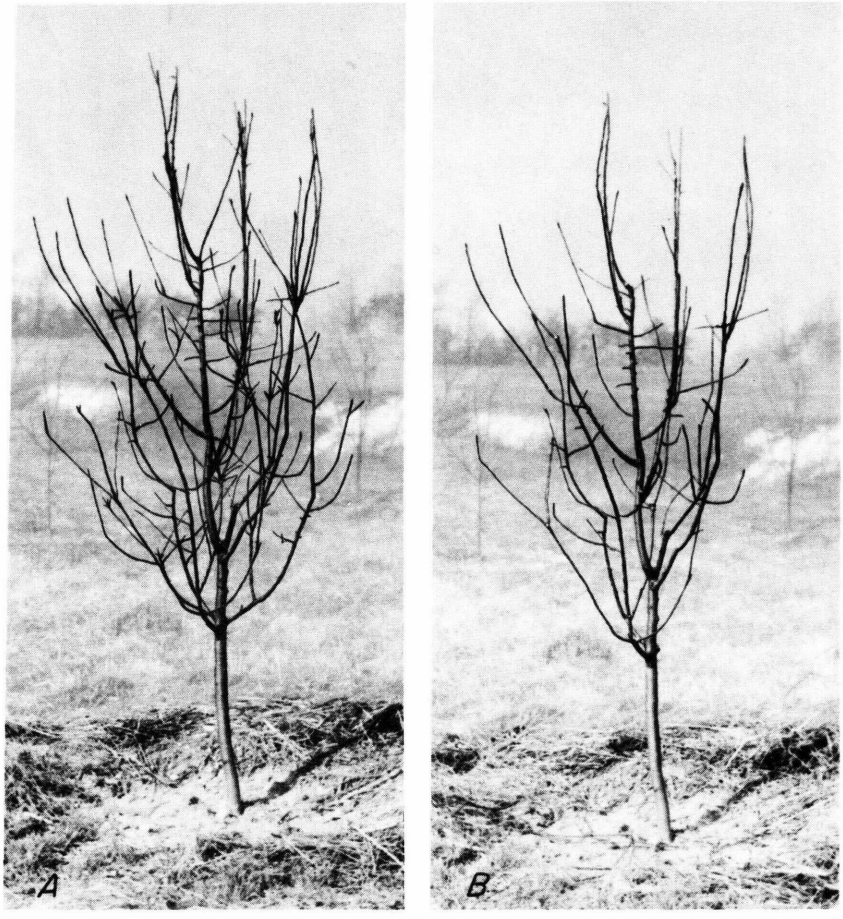

FIGURE 11.—A 3-year-old Rome Beauty apple tree before (*A*) and after (*B*) pruning.

lightly pruned or unpruned branch. This principle should be used in correcting bad crotches. If one of the scaffold limbs becomes nearly equal in size to the trunk or leader, it should be suppressed by heavier pruning than is applied to the rest of the tree.

It should be strongly emphasized, however, that pruning during this period should be light and consist primarily of thinning out

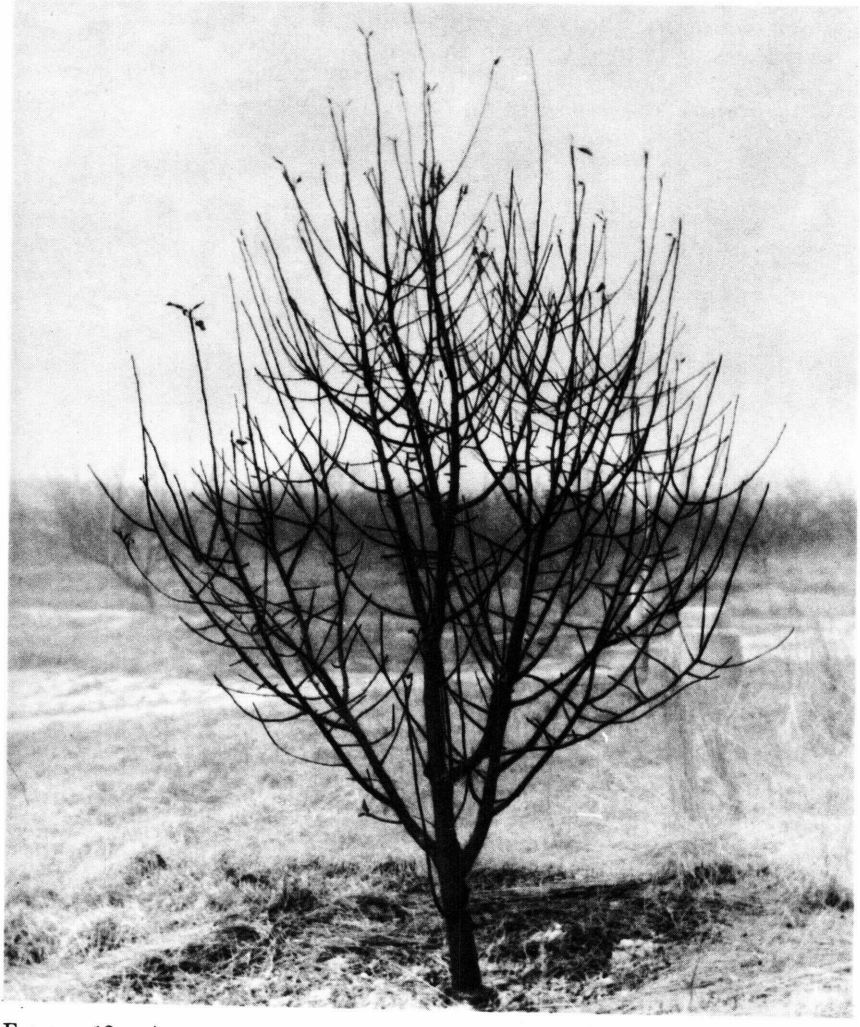

FIGURE 12.—A 4-year-old York Imperial apple tree before pruning. Pruning was primarily a thinning out of sucker growth from the trunk and scaffold limbs. A very little thinning in the top of the tree was all that was required.

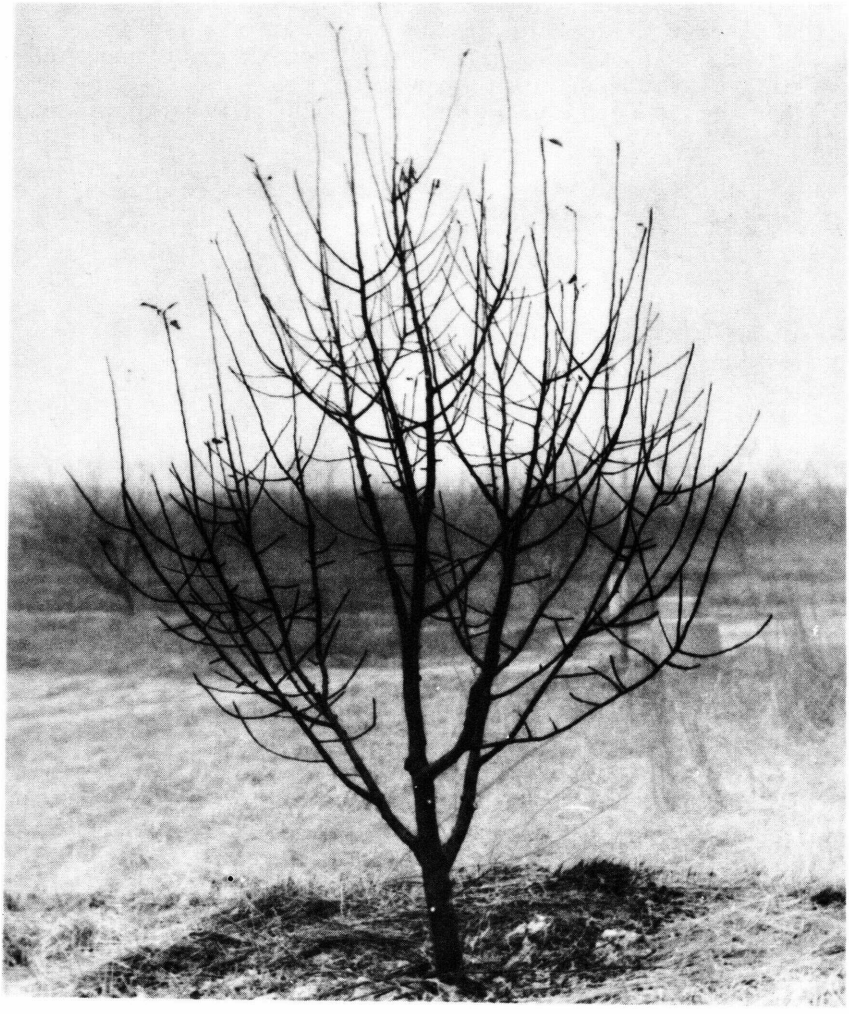

FIGURE 13.—The same tree as that in figure 12, after pruning.

rather than heading back branches. The heavier the pruning through this period the longer the time that will be required before the trees begin to produce fruit. If the tree has been well shaped during the first 2 years in the orchard, pruning for several years following can be very light and consist essentially in removing any undesirable growth that may come into the young trees.

When the trees come to bearing, the weight of the fruit will tend

FIGURE 14.—A 4-year-old Golden Delicious apple tree before (*A*) and after (*B*) pruning. No major cuts were required, but a light thinning out, primarily of sprouts coming from low down on the trunk or main scaffold limbs. Pruning consisted primarily of cutting out sprouts.

to spread the tree, and it will be much more open after it has borne a few crops than it will appear to be at 4 or 5 years of age.

REPLANTING OLD ORCHARDS

Frequently it is desirable to replant a site on which old trees are still growing. By the time most orchards are 35 years of age, they have passed their period of greatest commercial value. Frequently the grower wishes to reestablish a young orchard on the same site.

If the old trees are removed prior to the planting of young trees, at least a 10-year period will elapse before the orchard will again be near full production. Frequently growers resort to a practice of planting young trees between the old trees that they plan to remove a few years later.

The success of the latter method of handling will depend largely on the fertility of the soil, how close the old trees are planted, and the

FIGURE 15.—Young trees growing between old trees to renew the orchard. The old trees have not yet been removed.

care that is given the young trees. In general, such young trees in old orchards should receive as good care as has been described previously for young orchards, or even better. If the old trees are being grown in sod the young trees should be well mulched and well fertilized to promote growth.

The greatest problem in such young plantings in old orchards is the shading resulting from the old trees. Apple trees grown in shade

tend to make a spindling type of growth, with more slender branches than when grown in full sunlight. If the old trees are well spaced, the shading effect on the young trees may not be serious during the first few years. If the old trees are planted somewhat close, some of the larger branches should be cut off, increasing the light exposure to the young trees. In most cases the old trees should not be left longer than 5 years after the young trees are planted. Figure 15 shows such young trees grown between old trees, and figure 16 shows the same trees immediately after the old trees were removed. Although the lower branches on these young trees planted among the older trees developed less than they would have on trees grown in the

FIGURE 16.—Young trees grown until near bearing age between well-spaced old trees. The old trees were removed during the previous winter.

open, fairly satisfactory trees can be developed in this way. Needless to say, much time was saved in reestablishing the bearing orchard.

When the old trees are removed before replanting, it is usually desirable not to set the young trees in the same positions from which the old trees were removed. For reasons not entirely understood, young trees usually make poorer growth under such conditions than if planted in the middles, where root concentration from the old trees is more sparse. This may be due in part to the fact that the mineral plant-food elements are more largely exhausted from the immediate vicinity of an old tree than from other areas at a greater distance from the old trunks. In some sections root rots that have been established

on the old trees will attack and kill young trees planted in the spot formerly occupied by the old tree.

SPRAYING THE YOUNG ORCHARD

Much less spraying is necessary on trees prior to bearing age than is required to protect the fruit crop after they are in bearing. It is essential, however, that they be sprayed sufficiently to protect them from insects and diseases that interfere with the growth and development of the tree. In the humid parts of the United States, where apple scab is a serious disease, it is necessary to spray the trees sufficiently to protect the foliage from scab. Unsprayed trees may be defoliated by the scab fungus, in which case growth will be reduced and the trees will be seriously stunted. Two or three spray applications per year should be sufficient to protect such nonbearing trees from serious scab damage. In the drier parts of the country, spraying for protection from fungus diseases is usually not required.

In most parts of the country a dormant spray to keep the trees free of scale insects will also be necessary. In many localities it is also necessary to apply lead arsenate, or other stomach poison, or other insecticides 2 or 3 times for the control of caterpillars and other leaf-chewing insects. This material may often be combined with the fungicide that is applied for the control of fungus diseases. Growers should consult their State agricultural extension service for details relative to the spray program.

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√ Are water tanks, cisterns, and wells protected?

√ Are ladders and steps in good repair?

√ Are pitchforks, rakes, shovels, and other sharp tools kept in racks?

√ Are electric circuits and appliances in good condition?

√ Is unused lumber carefully stacked?

√ Are buildings and fences in good repair?

clean up your farm

to make it attractive and SAFE